Projectile Motion:

- Treat x- and y-directions independently
- Assumptions:
  - Object is in free-fall
  - Ignore air resistance
- Variables:
  - x-direction:
    $a_x (= 0\ m/s^2)$, v_{ix}, v_{fx}, Δx
  - y-direction:
    $a_y = a_g = 9.8\ m/s^2$ downward
    v_{iy}, v_{fy}, Δy
  - both directions:
    t, v_i, v_f, θ_i, θ_f
- Equations:

$\Delta x = v_{ix}t + \frac{1}{2}a_x t^2 \Rightarrow \Delta x = v_{ix}t$ ($a_x = 0$)

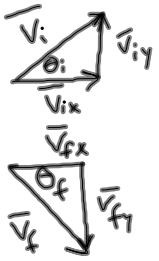
$v_{fx}^2 = v_{ix}^2 + 2a_x\Delta x \Rightarrow v_{fx}^2 = v_{ix}^2$ ($a_x = 0$)

$v_{fx} = v_{ix} + a_x t \Rightarrow v_{fy} = v_{ix}$ ($a_x = 0$)

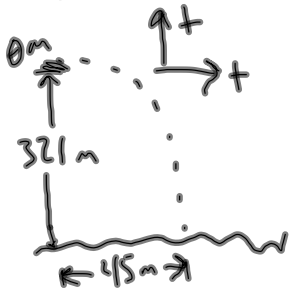
$\Delta y = v_{iy}t + \frac{1}{2}a_g t^2$

$v_{fy}^2 = v_{iy}^2 + 2a_g\Delta y$

$v_{fy} = v_{iy} + a_g t$



The Royal Gorge Bridge in Colorado rises 321 m above the Arkansas River. Suppose you kick a rock horizontally off the bridge. The magnitude of the rock's horizontal displacement is 45.0 m. Find the speed at which the rock was kicked.



$\Delta y = 321\ m \qquad t = ?$

$\Delta x = 45\ m$

$v_{iy} = 0\ m/s$

$v_{ix} = ?$

$$\Delta y = v_{iy}t + \frac{1}{2}a_g t^2$$

$$t = \sqrt{\frac{2\Delta y}{a_g}} = \sqrt{\frac{2(-321\ m)}{(-9.8\ m/s^2)}} = 8.09\ s$$

$$\Delta x = v_{ix}t$$

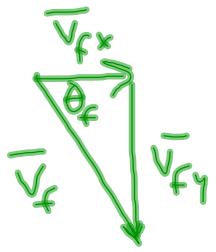
$$v_{ix} = \frac{\Delta x}{t} = \frac{45\ m}{8.09\ s} = 5.56\ m/s$$

Find v_f.

$$v_{fy} = v_{iy}^{0} + a_g t$$

$$= (-9.8\ m/s^2)(8.09\ s)$$

$$= -79.3\ m/s$$



$\bar{v}_f = 79.5\ m/s\ @\ 86°\ S\ of\ E$

$$\left(79.5\frac{m}{s}\right)\left(\frac{3600\ s}{1\ h}\right)\left(\frac{1\ km}{1000\ m}\right)\left(\frac{.62\ m}{1\ km}\right)$$

A cat chases a mouse across a 1.0 m high table. The mouse steps out of the way, and the cat slides off the table and strikes the floor 2.2 m from the edge of the table. When the cat slid off the table, what was its speed?

$V_{iy} = 0$ m/s $\quad \Delta y = 1$ m

$V_{ix} = ?$ $\quad \Delta x = 2.2$ m

$t = ?$

$$\Delta y = V_{iy}\cancel{t^0} + \frac{1}{2}a_g t^2$$

$$t = \sqrt{\frac{2\Delta y}{a_g}} = .45\ s$$

$$\Delta x = V_{ix} t \qquad V_{ix} = \frac{\Delta x}{t} = 4.89\ m/s$$